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FIELD EXPERIMENTS ON USE OF DUOLIT PREPARATIONS AGAINST MOSQUITO LARVAE

S. I. Kozhukhov, Engineer-Captain

Duolit preparations which have shown excellent insecticidal properties against many different types of insects were not sufficiently effective for mosquitoes.

The initial action of these preparations immediately after they were sprayed was very great, and all mosquitoes in the area died within a few minutes; but as soon as the spray settled, its action was ineffective. For the first few days after spraying, only mosquitoes coming in contact with the surfaces on which the preparation had settled died not less than 4 - 20 hours. After 3 - 5 days, the action of the preparations on mosquitoes was unnoticeable.

The substitution of fluorine for chlorine in the toxic group of the preparation also produced no results.

The failure in the use of duolit preparations against mosquitoes impelled us to test the preparations on mosquito larvae. A number of experiments were conducted in the summer of 1946 for this purpose.

Experiment 1

Eighty-six mosquito larvae of various types and in various phases of development were placed in a 2-liter glass jar. Then 0.05 grams of duolit powder (with a content of 20 percent DDT) were sprinkled on the surface of the water, but most of it quickly settled to the bottom. After 2 hours, the first- and second-phase larvae could not rise to the surface of the water. After 4 hours the third-phase larvae could not rise to the surface of the water. After 6 hours, all the larvae were lying on the bottom of the jar and moving about sluggishly. All larvae were dead on the following day.

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Experiment 2

Seventy larvae and 20 chrysalises were placed in a 4-liter jar. Then 0.04 grams of duolit emulsion (containing 20 percent DDT) were placed in the water. The drops of emulsion settled to the bottom (leaving white traces), and then dissolved in the water, having formed minute clouds which completely disappeared after the water was stirred. After 30 minutes the first- and second-phase larvae could not rise to the surface of the water. Five of these larvae were transferred to pure water. The third-phase larvae could not rise to the surface after 3 hours. After 5 hours all the larvae were lying on the bottom of the jar. The mosquito chrysalises showed no signs of being affected. After 24 hours all the larvae died, including those transferred into pure water. The chrysalises still showed no signs of being affected even after 48 hours.

Experiment 3

Seventy larvae and 30 chrysalises were placed in a 4-liter glass jar. Then 0.2 cubic centimeters of a solution of pure crystallic DDT in ethyl alcohol was placed in the water. After 20 minutes the first- and second-phase larvae were lying on the bottom of the jar. After 24 hours all the larvae were dead. The preparation showed no noticeable influence on the chrysalises. However, the mosquitoes emerging from the chrysalises after 3 days apparently had low viability, and almost all of them remained on the surface of the water. New larvae which were placed in the jar on the third day remained alive and showed no signs of affection.

Experiment 4

In this experiment, 10 cubic centimeters of a 2 percent solution of crystallic DDT in ethyl alcohol were poured in a cement basin (1.9 cubic meter capacity) containing a large quantity of larvae in various phases of development. After 3 hours not a single larva remained on the surface of the water. The chrysalises were as animated as before and during the next 24 hours mosquitoes emerged from them, some of which died and remained on the surface of the water. The remainder flew away, and it was impossible to observe them further. The observations were continued, and only after the 39th day the first few mosquito larvae were discovered in the basin. Prior to this time there were no mosquito larvae in it, in spite of the fact that weather conditions were very favorable for their appearance and development. It must be noted that during the time of the observation the water slowly ran out of the basin through cracks in the walls and the bottom, and it was necessary to refill it periodically. It can be reliably stated that during the observations the water in the reservoir was not changed once.

Experiment 5

A rectangular reservoir with a width of 13 meters, a length of 26 meters, and an average depth of 5 meters, was abundantly populated with various water insects, among them a very great number of mosquito larvae of various types and phases of development. Two hundred grams of duolit emulsion (sprayed from the shore from a wide-mouthed flask) were sprayed over the reservoir. For convenience in spraying, the duolit emulsion was diluted with water in a ratio of 1:1. The action of the duolit in this case was checked only on the fourth day. It was discovered that not a single living insect remained in the reservoir. The entire surface of the water was covered with the bodies of various water insects and mosquitoes, which apparently had died upon flying out of their chrysalises.

The experiment was conducted on 6 July 1946. Larvae were not discovered in the reservoir before the end of the summer. At the end of August, an insignificant number of bugs -- Dytiscidae and Hydrophilus -- appeared in the reservoir.

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Experiment 6

One of the dammed bypass channels of the Khafel' River, having a length of 6 kilometers, and a width of 400 meters, and a current which at times is almost imperceptible and at times reaching 1 - 2 centimeters per second, seemed a very favorable breeding place for mosquitoes with its shaded coves and covered motor-boat sheds. There were few larvae in open places, but many were found in the shaded coves and bathing places.

Four kilograms of duolit emulsion diluted with water in a ratio of 1:3 were put in a sector of the water 330 meters long by spraying from a hydraulic hose with a nozzle (spraying was done from the shore). Along the sandy beaches many schools of young fish could be observed violently swimming away from the shore when the duolit was sprayed over the water.

A check made after 48 hours revealed that all mosquito larvae along the shore had died. Many dead mosquitoes were floating on the surface of the water. No dead fish were discovered in the channel. The snails on the poles of the bathhouses were alive and creeping about.

Experiment 7

We refused to put duolit in an open reservoir-aquarium, with a length of 12 meters, a width of 4 meters, and a depth of 1 meter, containing an insignificant quantity of larvae, because of the fear of killing the fish in it. But several drops of emulsion (not more than 3 grams) dripped into the water from a jar of duolit emulsion placed on the wall of the reservoir. An examination after 48 hours disclosed that all the larvae in the reservoir had died. No signs of affection were noticed in the fish.

Experiment 8

A small round lake covering an area of 300 square meters and having an average depth of 1.5 meters, was populated with an enormous quantity of larvae and mosquito chrysalises. The lake, which was filled by ground water, drained into a small cove, with an exit into a narrow canal. The canal was separated from the cove by a wooden sluice gate. The ground water entering the lake was so insignificant that the water, not overflowing through the floodgate, only seeped through the cracks in it and formed a small stream with an insignificant current and discharge of water of not more than 0.2 liters per second in the bed of the canal.

In order to explain the capacity of duolit to diffuse in water, 100 grams of duolit emulsion diluted in 10 liters of water were poured into the lake from a point on the beach diametrically opposite the cove and the canal.

The first examination of the lake made in the evening of the same day showed that the first- and second-phase larvae had completely disappeared; the third- and fourth-phase larvae were still present in a considerable quantity. They were more numerous in the cove and the canal than in the section where the duolit had been poured. On the evening of the second day only a small quantity of fourth-phase larvae was discovered. By the morning of the third day the reservoir, the cove, and the canal were completely free from larvae. The mosquito chrysalises showed no signs of affection and mosquitoes emerged from them. On the fifth day the lake was free from chrysalises, which had changed into mosquitoes during this time.

Small fish, found in the lake in great quantities, showed no signs of being affected.

Systematic observations were not continued after the fifth day, but periodic examination of the lake disclosed that larvae did not appear before the end of the summer. There was no noticeable action of the duolit on the fish.

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On the day the duolit was poured into the lake (20 July 1945) a cool, rainy weather started and continued until the end of the summer, and evidently was not favorable for the development of larvae.

Experiment 9

Used in this experiment was a cement basin with a capacity of 1.9 cubic meters (the same used for Experiment A), containing a considerable amount of larvae of various phases of development. One gram of duolit-A-powder was strewn (from a sheet of paper) on the surface of the water which was approximately 2 square meters in area. Part of the powder which fell into the water remained on the surface and only a small part sank. This was mostly large particles and caked chunks of the powder. It may be said that 60 percent of the powder remained on the surface of the water, 10 percent sank, and 30 percent was blown away by the wind. After 3 hours in the first- and second-phase larvae died. After 24 hours the reservoir was free of larvae.

In this experiment it was especially interesting that the large number of Daphnia in the reservoir showed no signs of affection.

Data on the preparations used in these experiments and the concentration of DDT in them is presented in the following table.

Experiment Number	Month (1945)	Preparation Used in Experiment	Content of DDT in Preparation (in %)	Concentration of DDT in Reservoir (in g/m³)
1	Jun	Duolit powder	20	5.0
2	Jun	Duolit emulsion	20	2.0
3	Jun	Alcohol solution of DDT	2	1.0
4	Jun	Alcohol solution of DDT	2	0.1
5	Jun	Duolit emulsion of DDT	20	0.034
6	Jun	Duolit emulsion of DDT	20	Impossible to determine
7	Jul	Duolit emulsion of DDT	20	0.012
8	Jul	Duolit emulsion of DDT	20	0.044
9	Aug	Duolit-A-powder	5	0.026

CONCLUSIONS

1. The active substance (DDT) in all its forms definitely killed all phases of mosquito larvae; in comparison with other water insects, the mosquito larvae were apparently more susceptible to the action of this poison.

2. DDT in the concentrations used for the experiments was not effective against the chrysalises, but the mosquitoes emerging from these chrysalises apparently had less viability and many of them died soon after emerging from the chrysalis. In view of the fact that part of the mosquitoes which emerged from the chrysalises flew

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away and it was impossible to observe their larval [illegible] experiments with the chrysalises must be continued.

3. The lowest concentration of DDT used in the experiments was 0.012 gram per 1 cubic meter of water in the reservoir (Experiment 7). This concentration was thoroughly effective, but it was difficult to conclude whether or not this concentration was the minimum as experiments were not conducted with lower concentrations.

4. The concentration of DDT in the reservoir of 0.1 grams/cubic meter was not harmful to domestic birds, as in Experiments 4 and 9 no signs of affection were discovered in two domestic geese which were feeding in the reservoir and which drank from it.

5. Concentrations of 0.012 - 0.044 grams/cubic meter were harmless to fish, as in Experiments 7 and 8 fish which were in the reservoir were not affected. Also, no signs of affection were discovered in observations which were continued for more than 2 months. In Experiment 6, young fish which were temporarily affected at the moment the duolit was poured into the water in concentrations significantly higher than 0.044 grams/cubic meter also remained alive. A final conclusion in this case became more difficult, since (1) it was impossible to determine the initial concentration of DDT, and (2) the fish quickly left the zone of high concentration.

6. For mosquito larvae, as well as for other insects, the affection is apparently irreversible, as the larvae which had shown the least signs of affection and were transferred into pure water inevitably died at the same time as the larvae which were constantly under the action of the DDT (Experiment 2).

7. The action of the DDT was not instantaneous, i.e., killing only those larvae which were in the reservoir at the moment it was treated. In all the experiments with natural reservoirs, one treatment in July was sufficient to prevent larvae from appearing before the end of the summer. An exception to this was Experiment 4, in which the larvae appeared again after a month. But in this experiment the water in the reservoir was constantly changed, and an alcohol solution of DDT was used, which was less successful in the sense of keeping the active substance in the water. However, the experiments on the duration of the action of duolit must be verified, as the absence of larvae in the reservoirscan be explained also by the unfavorable weather during the end of the summer.

8. A comparison of the various preparations of DDT for their actions and convenience of use indicated the following:

a. Alcohol solutions should not be used, as the DDT does not dissolve in water; upon introducing the solution into the water, the DDT quickly precipitates out of the alcohol solution.

b. Most of the duolit powder slowly sank to the bottom; only an insignificant quantity remained on the surface where it was particularly needed.

c. A special preparation of duolit powder to combat larvae remained on the surface of the water. However, this preparation required very fine spraying, which complicated the treatment of large reservoirs.

d. Duolit emulsion in its usual form was very well distributed in the water; from Experiments 7 and 8 it could be seen that the introduction of emulsion in one point made certain the death of larvae in the entire reservoir even in absolutely stationary water, as this took place in the case with the aquarium.

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